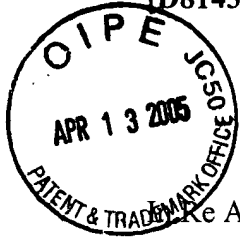


Express Mail Label EV516214373US
PATENT
[D8143-00300]

ATTORNEY DOCKET: TONG 2



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Re Application of: Dennis Tong

Confirmation No. 6646

Serial No. 10/015,477

Examiner: Payne, David C.

Filed: December 13, 2001

Group Art Unit: 2633

For: Opto-Electronic Phase-Locked Loop with Microwave Mixing for Clock Recovery

Certification under 37 CFR § 1.10

EXPRESS MAIL LABEL NO: **EV516214373US**

I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the U.S. Postal Service in an envelope as "EXPRESS MAIL POST OFFICE TO ADDRESSEE" service under 37 CFR § 1.10, Mailing Label Number as listed above, addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

Date

April 13, 2005

By

Mary La Grange

M.S. Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Petition Accompanying a Declaration Under 37 C.F.R. 1.131 Made by the Assignee

Petition is made hereby to accept an enclosed Declaration under 37 CFR 1.131,
(hereafter, the Declaration).

The Declaration is made by the Assignee, when it is not possible to produce the affidavit or declaration of the inventor. Under MPEP 715.04 (D), "Affidavits or declarations to overcome a rejection of a claim or claims must be made by the inventor or inventors ..., a party qualified under 37 CFR 1.42, 1.43, or 1.47, or the assignee or other party in interest when it is not possible to produce the affidavit or declaration of the inventor(s)."

04/15/2005 MBIZUNES 00000046 041679 10015477
01 FC:1463 200.00 DA

It is believed that a petition fee is not required, because an assignment is recorded at reel/frame, 012398/0753, and further, because, the Declaration is submitted by the Assignee of record. The Assignee of record is already a party, and does not require a petition to become a party qualified under 37 CFR 1.42, 1.43, or 1.47. However, if a petition fee is required under 37 CFR 1.17, authorization is made hereby to charge the petition fee of \$200.00, and any balance of fee due, to Deposit Account 04-1679.

April 13, 2005
Date

Gerald K. Kita
Gerald K. Kita
Registration No. 24,125

Customer No. 08933
DUANE MORRIS LLP
One Liberty Place
Philadelphia, PA 19103-7396
Telephone: 215-979-1000
Direct Dial: 215-979-1863
Facsimile: 215-979-1020



DECLARATION UNDER 37 C.F.R. 1.131

Declarant, Scott W. McLellan, in behalf of Agere Systems Inc., Assignee of the present application, declares the following:

The present Declaration under 37 C.F. R. 1.131 is submitted by the Assignee, when it is not possible to produce the affidavit or declaration of the inventor, as provided for by MPEP 715.04(D).

Dennis Tong is the sole inventor of inventions and discoveries (hereafter, "the invention") described in U.S. Application Number 10/015,477, filed December 13, 2001, claiming the benefit of U.S. Provisional Application Number 60/294,693, filed May 31, 2001. All claims 1-24 in said U.S. Application Number 10/015,477, are rejected under 35 U.S. C. 102, as being unpatentable over a publication having a publication date of November 9, 2000.

(1.) Proof that the Inventor, Dennis Tong, can not be reached. Under my direction and control, Gerald K. Kita, registration number 24, 125, performed the following acts attempting to reach the Inventor, without success.

A letter was sent to the Inventor's last known address, by UPS overnight deliver service, and could not be delivered to the addressee. The letter and an enclosure of the letter describes the need for an affidavit, as well as, a summary of such an affidavit. A copy of the letter and bill of lading from UPS overnight delivery service is enclosed as **Exhibit A**.

A telephone call was placed on March 3, 2005 to the inventor's last known telephone number, and was answered by a recorded message that the telephone number has been disconnected.

On March 14, 2005, a commercial search was purchased to provide the inventor's unlisted telephone number at the inventor's last known address. On that same date, a phone call placed to the unlisted telephone number was answered by a recorded message that the (unlisted) telephone number has been disconnected.

A search on the Internet using the Yahoo website turned up telephone numbers for three persons named, "Dennis Tong." Telephone calls placed to these persons confirmed that none of them is the sole inventor.

An effort to reach the sole inventor at his last known employer was unsuccessful. The inventor's last known employer, Tellium, Inc. is no longer listed on the NASDAQ stock exchange under its previously known ticker symbol, TELM, and has no publicly known address or telephone number. The website, "tellium.com" is no longer available on the Internet.

The Following further proofs are submitted by this Declaration.

(2.) Proof that an acceptable oath or declaration signed by the Inventor, in compliance with 35 U.S.C. §§ 115 and 116, has previously been filed with the present application, and is of record in the present application. A copy of the declaration signed by the Inventor is enclosed as **Exhibit B**.

(3.) An authorization to charge a petition fee, if such a fee is deemed necessary for filing the Declaration. A copy of the petition and fee authorization is submitted as **Exhibit C**.

(4.) A statement of the last known address of the Inventor. A statement of the last known address of the inventor is submitted as **Exhibit D**.

(5.) Proof of proprietary interest in the Assignee, by way of an Assignment executed by the Inventor, recorded at reel/frame 012398/0753, and a Statement Under 37 C.F.R. 3.73 (b) by the Assignee, form PTO/SB/96 (08-00). An Assignment was signed by the sole inventor, Dennis Tong, which Assignment was filed together with the present application, and is of record in the present application. A copy of the recorded Assignment is submitted, together with, a copy of the Statement Under 37 C.F.R. 3.73 (b), which is redacted to show the relevant portions, as **Exhibit E**.

(6.) Proof that a filing date and application serial number of the present application for patent has been granted. The Declaration herein is being submitted to preserve the rights of the party or prevent irreparable damage, as provided by MPEP 409.03(g). The present application would become abandoned, causing irreparable harm, unless the Petition (Exhibit C) is granted to preserve the rights of the Parties. A copy of the filing receipt of the present application is submitted as **Exhibit F**.

(7.) Evidence of conception of the invention prior to November 9, 2000. All Claims 1-24, of the present application are rejected under 35 USC 102, as being anticipated by a publication having the publication date of November 9, 2000. See **Exhibit G**.

Exhibit G, 15 pages, includes a copy of an unpublished technical paper, together with a copy of a cover letter, dated (prior to November 9, 2000), to Jeffrey Brosemer of Lucent. The cover letter was signed by Lisa M Connolly/for Dennis Tong, which letter requests a publication release of the technical paper. The letter indicates an "APPROVAL DATE," (prior to November 9, 2000).

(8.) The following facts and Exhibits with actual dates are submitted as evidence of acts relied on to establish due diligence, in compliance with MPEP 715.07 and 715.07(a).

Exhibit H, three pages, includes a copy of a memorandum, dated June 22, 2000, signed by Jeffrey J. Brosemer of Lucent. According to page 1 of Exhibit H, the unpublished technical paper (Exhibit G) was given an IDS # 122690. Further page 1 of Exhibit H states, "Patentability item #122690 has been formally docketed to consider the patentability of the above-identified subject matter. D.T.K. Tong appears to be the originator."

Exhibit I, two pages, includes a copy of a publication, on November 9, 2000, of the previously unpublished technical paper (Exhibit G). The publication is identified as, D.K.T. Tong, Kung-Li Deng, M. Mikkelsen, G. Rabon, K. F. Dryer, J. E. Johnson, 160 Gbit/s clock recovery using electroabsorption modulator-based phase-locked loop, *ELECTRONIC LETTERS*, Vol. 36, No. 23, Pp. 1951-1952. November 9, 2000.

Exhibit J, one page, is a copy of a memorandum, dated January 26, 2001, signed by Gregory C. Ranieri of Lucent, indicating transfer of IDS # 122690 (Exhibit H) to Agere. Prior to the date of Exhibit J, Lucent was undergoing legal reorganization, which resulted in Agere being spun off from Lucent as a separate legal entity, and further, being approved to become a successor in interest (Exhibit E) of the rights in IDS # 122690 (Exhibit H).

Exhibit K, one page, is a form, dated February 21, 2001, entitled, "SUBMISSION/CASES REFERRED TO OUTSIDE COUNSEL," and referring to IDS #122690 (Exhibit B). The purpose of the form is to approve IDS # 122690 (Exhibit H) for a patent application to be prepared by outside counsel, which ultimately resulted in U.S. Provisional Application Number 60/294,693, filed May 31, 2001, and U.S. Application Number 10/01477,

filed, December 13, 2001, claiming the benefit of U.S. Provisional Application Number 60/294,693, filed May 31, 2001.

The following evidence of constructive reduction to practice is submitted by this Declaration.

(9.) Dennis Tong is the sole inventor named in the present U.S. Application Number 10/01477, filed, December 13, 2001, claiming the benefit of U.S. Provisional Application Number 60/294,693, filed May 31, 2001.

Declarant has the authority of the Assignee to act in its behalf regarding this Declaration.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Scott W. McLellan date 12 Apr 05

for Agere Systems Inc.

Printed Name: Scott W. McLellan

Title: Assistant Secretary

DuaneMorris

FIRM and AFFILIATE OFFICES

GERALD K. KITA
DIRECT DIAL: 215.979.1863
E-MAIL: gkkita@duanemorris.com

www.duanemorris.com

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PRINCETON
WESTCHESTER

March 25, 2005

VIA FEDEX

Mr. Dennis Tong
1716 Knollwood Drive
Middletown, NJ 07748

Re: New U.S. Patent Application "Opto-Electronic Phase-Locked Loop with
Microwave Mixing for Clock Recovery"

Serial No: 10/015,477

Filed: December 13, 2001

Duane Ref: D8143-00300

Agere Ref: TONG 2

Dear Mr. Tong:

Enclosed is an e-mail regarding the captioned application. Please get in touch with me at your earliest opportunity so that we can discuss the application.

Best regards,



Gerald K. Kita
Special Counsel

GKK/mlg
Enclosure

cc: J. Powers



Kita, Gerald K.

From: Kita, Gerald K.
Sent: Thursday, March 03, 2005 1:32 PM
To: 'Dennis_Tong@hotmail.com'
Subject: FW: US Patent Application, Your ref: TONG-2 (Dennis Tong), Our File No.: D8143-00300A
Attachments: Document.pdf

Dear Dennis:

Joe Powers prepared and filed a patent application for your Clock Recovery Circuit.

All Claims 1-24 in the patent application are rejected under 35 USC 102 in view of a published article written by the inventor, Dennis Tong, and others. The article was published on November 9, 2000, by *Electronic s Letters* and indeed was the basis for drafting the U.S. patent application.

We need to prepare an affidavit or declaration signed by you, and stating that you are the sole inventor and the others (co-authors) were acting under your direction. If you can truthfully sign the affidavit or declaration, then the patent application will be allowed to issue into a US patent.

Please let me have your current mailing address and phone number.

Feel free to phone me if you have any questions.

Best regards,
Gerry K. Kita
Duane Morris LLP
One Liberty Place
Philadelphia, PA 19103
Phone: 215-979-1863
Fax: 215-979-1020

From: Kita, Gerald K.
Sent: Wednesday, March 02, 2005 5:16 PM
To: 'smcdellan@agere.com'
Subject: US Patent Application, Your ref: TONG-2 (Dennis Tong), Our File No.: D8143-00300A

Dear Scott:

All Claims 1-24 are rejected under 35 USC 102 in view of a published article written by the inventor, Dennis Tong, and others. The article was published on November 9, 2000, by *Electronic s Letters* and indeed was the basis for drafting the U.S. patent application, first, as a provisional application filed on May 31, 2001, within seven months after the publication date.

A provisional was filed while Lucent and Agere were working out an ownership transfer.

We can disqualify the publication as prior art in one of two ways. First, we could swear behind the publication date by proving an earlier conception date coupled with diligence until filing the provisional application. Alternatively we can file a Rule 132 affidavit showing Tong is the sole inventor of the invention disclosed by the publication.

In any case, we need documents showing the conception date, most likely in the form of Lucent's (Agere's) formal invention disclosure. Can this be obtained?

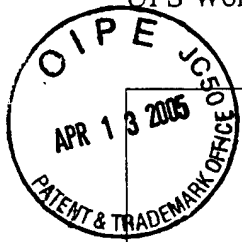
Next, we will need to contact the inventor, Dennis Tong, who is last known to be employed by a company, Tellium in Ocean Port, New Jersey. Can we obtain a Lucent (Agere) forwarding address and phone number for Mr. Tong?

Attached is a copy of the publication for your information.

Gerry K. Kita
Duane Morris LLP
One Liberty Place
Philadelphia, PA 19103
Phone: 215-979-1863
Fax: 215-979-1020



Document.pdf (583
KB)



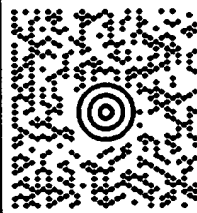
LTR 1 OF 1

PETER J. CRONK
(215) 979-1252
DUANE MORRIS LLP
ONE LIBERTY PLACE
PHILADELPHIA PA 19103

SHIP TO:

MR. DENNIS TONG
(732) 923-4100
MR. DENNIS TONG
1716 KNOLLWOOD DRIVE
MIDDLETOWN NJ 07748

NJ 077 0-05



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**IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE**

Declaration and Power of Attorney

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **OPTO-ELECTRONIC PHASE-LOCKED LOOP WITH MICROWAVE MIXING FOR CLOCK RECOVERY** the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to in this oath or declaration.

I acknowledge the duty to disclose all information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

None

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

U.S. Provisional Application Serial No. 60/294,693, Filed May 31, 2001

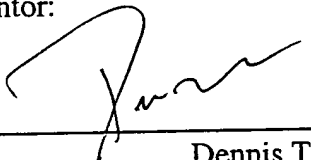
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorney(s) with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected therewith:

Lester H. Birnbaum	(Reg. No. 25830)
Richard J. Botos	(Reg. No. 32016)
Gerard A. deBlasi	(Reg. No. 34149)
Anthony Grillo	(Reg. No. 36535)
Mark A. Kurisko	(Reg. No. 38944)
Robert P. Marley	(Reg. No. 32914)
Scott W. McLellan	(Reg. No. 30776)
Geraldine Monteleone	(Reg. No. 40097)
Scott J. Rittman	(Reg. No. 39010)
Ferdinand M. Romano	(Reg. No. 32752)
David L. Smith	(Reg. No. 30592)
John P. Veschi	(Reg. No. 39058)

I hereby appoint the attorney(s) on ATTACHMENT A as associate attorney(s) in the aforementioned application, with full power solely to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected with the prosecution of said application. No other powers are granted to such associate attorney(s) and such associate attorney(s) are specifically denied any power of substitution or revocation.

Full name of sole inventor:

Inventor's signature  Date 11/9/2001
Dennis Tong

Residence: 1716 Knollwood Drive
Middletown, NJ 07748

Citizenship: Chinese

Post Office Address: Same as above.

ATTACHMENT A

Attorney Names:	William H. Murray	Reg. No.	27,218
	Peter J. Cronk		32,021
	Robert E. Rosenthal		33,450
	Steven E. Koffs		37,163
	Darius C. Gambino		41,472
	Lewis F. Gould, Jr.		25,057
	Stephan P. Gribok		29,643
	Samuel W. Apicelli		36,427
	Anthony Colesanti		42,428
	Richard A. Paikoff		34,892
	Richard T. Redano		32,292
	Joseph A. Powers		47,006
	Gary R. Maze		42,851
	Melanie Goddard		46,732
	Joseph F. Oriti		47,835
	Arthur L. Plevy		24,277
	Edward J. Howard		42,670
	Jane E. Alexander		36,014
	Paul A. Schwarz		37,577
	Carl A. Giordano		41,780
	Gail A. Dalickas		40,979

Telephone calls should be made to **Joseph A. Powers** at:

Phone No.: (215) 979-1842

Fax No.: (215) 979-1020

All written communications are to be addressed to:

William H. Murray
Customer No. 08933
DUANE, MORRIS & HECKSCHER, LLP
 One Liberty Place
 Philadelphia, PA 19103-7396
 (215) 979-1264

D8143-00300

Express Mail Label: EL714882049US

Response to Office Action Dated December 17, 2004

Petition Accompanying a Declaration Under 37 C.F.R. 1.131 Made by the Assignee

Petition is made hereby to file an enclosed Declaration under 37 CFR 1.131, (hereafter, the Declaration).

The Declaration is made by the Assignee, when it is not possible to produce the affidavit or declaration of the inventor. Under MPEP 715.04 (D), "Affidavits or declarations to overcome a rejection of a claim or claims must be made by the inventor or inventors ..., a party qualified under 37 CFR 1.42, 1.43, or 1.47, or the assignee or other party in interest when it is not possible to produce the affidavit or declaration of the inventor(s)."

It is believed that a petition fee is not required, because an assignment is recorded at reel/frame, 012398/0753, and further, because, the Declaration is submitted by the Assignee of record. The Assignee of record is already a party, and does not require a petition to become a party qualified under 37 CFR 1.42, 1.43, or 1.47. However, if a petition fee is required under 37 CFR 1.17, authorization is made hereby to charge the petition fee of \$200.00, and any balance of fee due, to Deposit Account 04-1679.

(copy for petition purposes)

Date

Gerald K. Kita
Registration No. 24,125
Customer No. 08933
DUANE MORRIS LLP
One Liberty Place
Philadelphia, PA 19103-7396
Telephone: 215-979-1000
Direct Dial: 215-979-1863
Facsimile: 215-979-1020

STATEMENT OF THE LAST KNOWN ADDRESS OF THE INVENTOR

The last known address of the inventor is:

1716 Knollwood Drive

Middletown, NJ 07748

March 28, 2005
(Date)

By: _____

Gerald K. Kita

Gerald K. Kita

Registration No. 24,125

Customer No. 08933

DUANE MORRIS LLP

One Liberty Place

Philadelphia, PA 19103-7396

Direct Dial: 215-979-1863

Facsimile: 215-979-1020



UNITED STATES
PATENT AND
TRADEMARK OFFICE

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umm

FEBRUARY 19, 2002

PTAS

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Director of the United States Patent and Trademark Office
Washington, DC 20231
www.uspto.gov

DUANE, MORRIS & HECKSCHER LLP
WILLIAM H. MURRAY, ESQUIRE
ONE LIBERTY PLACE
PHILADELPHIA, PA 19103



101929105A

UNITED STATES PATENT AND TRADEMARK OFFICE
NOTICE OF RECORDATION OF ASSIGNMENT DOCUMENT

FEB 25 2002

THE ENCLOSED DOCUMENT HAS BEEN RECORDED BY THE ASSIGNMENT DIVISION OF THE U.S. PATENT AND TRADEMARK OFFICE. A COMPLETE MICROFILM COPY IS AVAILABLE AT THE ASSIGNMENT SEARCH ROOM ON THE REEL AND FRAME NUMBER REFERENCED BELOW.

PLEASE REVIEW ALL INFORMATION CONTAINED ON THIS NOTICE. THE INFORMATION CONTAINED ON THIS RECORDATION NOTICE REFLECTS THE DATA PRESENT IN THE PATENT AND TRADEMARK ASSIGNMENT SYSTEM. IF YOU SHOULD FIND ANY ERRORS OR HAVE QUESTIONS CONCERNING THIS NOTICE, YOU MAY CONTACT THE EMPLOYEE WHOSE NAME APPEARS ON THIS NOTICE AT 703-308-9723. PLEASE SEND REQUEST FOR CORRECTION TO: U.S. PATENT AND TRADEMARK OFFICE, ASSIGNMENT DIVISION, BOX ASSIGNMENTS, CG-4, 1213 JEFFERSON DAVIS HWY, SUITE 320, WASHINGTON, D.C. 20231.

RECORDATION DATE: 12/13/2001

REEL/FRAME: 012398/0753
NUMBER OF PAGES: 3

BRIEF: ASSIGNMENT OF ASSIGNOR'S INTEREST (SEE DOCUMENT FOR DETAILS).

ASSIGNOR:
TONG, DENNIS

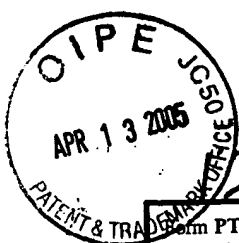
DOC DATE: 12/07/2001

ASSIGNEE:
AGERE SYSTEMS GUARDIAN CORP.
9333 S. JOHN YOUNG PARKWAY
ROOM 301E1211
ORLANDO, FLORIDA 32819

SERIAL NUMBER: 10015477
PATENT NUMBER:

FILING DATE:
ISSUE DATE:

SAUNDRA BALLENGER, EXAMINER
ASSIGNMENT DIVISION
OFFICE OF PUBLIC RECORDS



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(Rev. 03/01)

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To the Honorable Commissioner of Patents and Trademarks: Please record the attached original documents or copy thereof.

1. Name of conveying party(ies):

Dennis Tong

Additional name(s) of conveying party(ies) attached? ☐ Yes ☒ No

3. Nature of conveyance:

☒ Assignment☐ Merger☐ Security Agreement☐ Change of Name☐ Other _____

Execution Date: _____

2. Name and address of receiving party(ies)

Name: Agere Systems Guardian Corp.

Internal Address: _____

Street Address: 9333 S. John Young ParkwayRoom 301E1211City: Orlando State: FL Zip: 32819Additional name(s) & address(es) attached? ☐ Yes ☒ No

4. Application number(s) or patent number(s):

If this document is being filed together with a new application, the execution date of the application is: 11/09/2001

A. Patent Application No.(s)

10/015477

B. Patent No.(s)

Additional numbers attached? ☐ Yes ☒ No

5. Name and address of party to whom correspondence concerning document should be mailed:

Name: William H. Murray, Esquire

Internal Address: _____

Street Address: Duane, Morris & Heckscher LLPOne Liberty PlaceCity: Philadelphia State: PA Zip: 191036. Total number of applications and patents involved: 17. Total fee (37 CFR 3.41).....\$ 40.00☐ Enclosed☒ Authorized to be charged to deposit account

8. Deposit account number:

50-1735

(Attach duplicate copy of this page if paying by deposit account)

DO NOT USE THIS SPACE

9. Statement and signature.

*To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document.*Joseph A. Powers, Esquire

Name of Person Signing

Joseph A. Powers
SignatureDecember 13, 2001
DateTotal number of pages including cover sheet, attachments, and documents: 3Mail documents to be recorded with required cover sheet information to:
Commissioner of Patents & Trademarks, Box Assignments
Washington, D.C. 20231

12/31/2001 LMUELLER 00000204 501735 10015477

01 FC:581

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ASSIGNMENT AND AGREEMENT

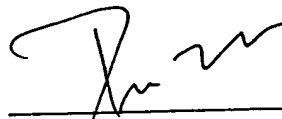
For value received, I, Dennis Tong of 1716 Knollwood Drive, Middletown in the County of Monmouth and State of New Jersey, hereby sell, assign and transfer to Agere Systems Guardian Corp., a corporation of the State of Delaware, having an office at 9333 S. John Young Parkway, Room 301E1211, Orlando, FL 32819, U.S.A., and its successors, assigns and legal representatives, the entire right, title and interest, for the United States of America, in and to certain inventions related to **OPTO-ELECTRONIC PHASE-LOCKED LOOP WITH MICROWAVE MIXING FOR CLOCK RECOVERY** described in an application for Letters Patent of the United States, executed by me of even date herewith, and all the rights and privileges in said application and under any and all Letters Patent that may be granted in the United States for said inventions; and I also concurrently hereby sell, assign and transfer to Agere Systems Guardian Corp. the entire right, title and interest in and to said inventions for all countries foreign to the United States, including all rights of priority arising from the application aforesaid, and all the rights and privileges under any and all forms of protection, including Letters Patent, that may be granted in said countries foreign to the United States for said inventions.

I authorize Agere Systems Guardian Corp. to make application for such protection in its own name and maintain such protection in any and all countries foreign to the United States, and to invoke and claim for any application for patent or other form of protection for said inventions, without further authorization from me, any and all benefits, including the right of priority provided by any and all treaties, conventions, or agreements.

I hereby consent that a copy of this assignment shall be deemed a full legal and formal equivalent of any document which may be required in any country in proof of the right of Agere Systems Guardian Corp. to apply for patent or other form of protection for said inventions and to claim the aforesaid benefit of the right of priority.

I request that any and all patents for said inventions be issued to Agere Systems Guardian Corp. in the United States and in all countries foreign to the United States, or to such nominees as Agere Systems Guardian Corp. may designate.

I agree that, when requested, I shall, without charge to Agere Systems Guardian Corp. but at its expense, sign all papers, and do all acts which may be necessary, desirable or convenient in connection with said applications, patents, or other forms of protection.


Dennis Tak Tong

JEFFREY JAMES BROSEMER
A Notary Public of New Jersey
My Commission Expires August 10, 2005


Date: 12.7.01

United States of America)

State of New Jersey) ss.:

City of W. Long Branch)

On this 7th day of December, 2001, before me personally came **Dennis Tak Tong**, to me known to be the individual described in and who executed the foregoing instrument, and acknowledged execution of the same.


Notary Public

Agere Systems Guardian Corp.
9333 S. John Young Parkway
Room 301E1211
Orlando, FL 32819

D8143-00300

PTO/SB/96 (08-00)

Approved for use through 10/31/2002 OMB 0651-0031

U. S. Patent and Trademark Office; U. S. DEPARTMENT OF COMMERCE

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STATEMENT UNDER 37 CFR 3.73(b)Applicant/Patent Owner: Agere Systems Inc.

Application No./Patent No.: _____ Filed/Issued Date: _____

Entitled: _____
Agere Systems Inc. corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

States that it is :

1. ☒ the assignee of the entire right, title, and interest; or
2. ☐ an assignee of less than the entire right, title and interest.
The extent (by, percentage) of its ownership interest is _____ %

In the patent application/patent identified above by virtue of either:

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

OR

B. ☒ A Chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as shown below:

1. From Inventor(s) To: Lucent Technologies Inc.
The document was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.
2. From Lucent Technologies Inc. To: Agere Systems Optoelectronics Guardian Corp.
The document was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.
3. From Agere Systems Optoelectronics Guardian Corp. To: Agere Systems Guardian Corp.
The document was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.
4. From Agere Systems Guardian Corp. To: Agere Systems Inc.
The document was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.☒ Copies of assignments or other documents in the chain of title are attached.

[Note: A separate copy (i.e., the original assignment document or a true copy of the original document) must be submitted to Assignment Division in accordance with 37 CFR Part 3, if the assignment is to be recorded in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Date_____
Typed or printed name_____
Signature_____
Corporate Counsel
Title

Delaware

PAGE 1

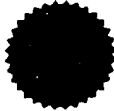
The First State

I, HARRIET SMITH WINDSOR, SECRETARY OF STATE OF THE STATE OF DELAWARE, DO HEREBY CERTIFY THE ATTACHED IS A TRUE AND CORRECT COPY OF THE CERTIFICATE OF OWNERSHIP, WHICE MERGES:

"AGERE SYSTEMS GUARDIAN CORP.", A DELAWARE CORPORATION, WITE AND INTO "AGERE SYSTEMS INC." UNDER THE NAME OF "AGERE SYSTEMS INC.", A CORPORATION ORGANIZED AND EXISTING UNDER THE LAWS OF THE STATE OF DELAWARE, AS RECEIVED AND FILED IN THIS OFFICE THE TWENTY-NINTH DAY OF AUGUST, A.D. 2002, AT 9 O'CLOCK A.M.

AND I DO HEREBY FURTHER CERTIFY THAT THE EFFECTIVE DATE OF THE AFORESAID CERTIFICATE OF OWNERSHIP IS THE THIRTY-FIRST DAY OF AUGUST, A.D. 2002.

A FILED COPY OF THIS CERTIFICATE HAS BEEN FORWARDED TO THE NEW CASTLE COUNTY RECORDER OF DEEDS.



Harriet Smith Windsor
Harriet Smith Windsor, Secretary of State

3268412 8100M

AUTHENTICATION: 1959517

020545223

DATE: 08-29-02

STATE OF DELAWARE
SECRETARY OF STATE
DIVISION OF CORPORATIONS
FILED 09:00 AM 08/29/2002
020545223 - 3268412

CERTIFICATE OF OWNERSHIP AND MERGER

OF

Agere Systems Guardian Corp.
(a Delaware corporation)

INTO

Agere Systems Inc.
(a Delaware corporation)

UNDER SECTION 253 OF THE GENERAL CORPORATION LAW OF THE STATE OF DELAWARE

Agere Systems Inc., a corporation organized and existing under the laws of Delaware ("Corporation"), DOES HEREBY CERTIFY:

FIRST: The Corporation is the owner of all of the outstanding shares of common stock of Agere Systems Guardian Corp., which is also a business corporation of the State of Delaware.

SECOND: On August 22, 2002 the Subsidiary Governance Committee of the Board of Directors of the Corporation adopted the following resolution to merge Agere Systems Guardian Corp. into the Corporation:

RESOLVED that Agere Systems Guardian Corp., a Delaware corporation, shall be merged with and into Agere Systems Inc., a Delaware corporation, with Agere Systems Inc. being the surviving corporation, and Agere Systems Inc. shall thereupon assume all of the obligations of Agere Systems Guardian Corp."

THIRD: That the merger authorized hereby shall become effective as of 8:00 a.m. Eastern Standard Time on August 31, 2002.

Executed on August 22, 2002

AGERE SYSTEMS INC.

By Paul Berto
Paul Berto, Vice President

STATE OF DELAWARE
SECRETARY OF STATE
DIVISION OF CORPORATIONS
FILED 09:00 AM 08/24/2001
010418909 - 3216123

CERTIFICATE OF MERGER
OF
AGERE SYSTEMS OPTOELECTRONICS GUARDIAN CORP.
WITH AND INTO
AGERE SYSTEMS GUARDIAN CORP.
UNDER SECTION 251 OF THE GENERAL
CORPORATION LAW OF THE STATE OF DELAWARE

Pursuant to Section 251(c) of the General Corporation Law of the State of Delaware, Agere Systems Guardian Corp. hereby certifies the following information relating to the merger of Agere Systems Optoelectronics Guardian Corp. with and into Agere Systems Guardian Corp.:

1. The names and states of incorporation of each constituent corporation in the merger are:

Name	State of Incorporation
Agere Systems Optoelectronics Guardian Corp.	Delaware
Agere Systems Guardian Corp.	Delaware

2. An Agreement and Plan of Merger setting forth the terms and conditions of the merger, has been approved, adopted, certified, executed and acknowledged by each of Agere Systems Optoelectronics Guardian Corp. and Agere Systems Guardian Corp. in accordance with the provisions of Section 251(c) of the General Corporation Law of the State of Delaware.

3. The name of the surviving corporation in the merger is Agere Systems Guardian Corp.

4. The Certificate of Incorporation of Agere Systems Guardian Corp. shall be the Certificate of Incorporation of the surviving corporation.

5. The executed Agreement and Plan of Merger is on file at the principal place of business of Agere Systems Guardian Corp. at Two Oak Way, Berkeley Heights, NJ 07922.

6. A copy of the Agreement and Plan of Merger will be furnished by Agere Systems Guardian Corp. on request and without cost, to any stockholder of Agere Systems Guardian Corp. or Agere Systems Optoelectronics Guardian Corp.

See 28-2001 04:28am

From:AGERE SYSTEMS INC.

0005026766

0005026766

T-642 P.006/006 F-005

7. The authorized capital stock of Agere Systems Optoelectronics Guardian Corp. is 1,000 shares of common stock, no par value per share.

8. The Merger shall be effective as of 9:00 a.m. Eastern Standard Time on August 31, 2001.

IN WITNESS WHEREOF, this Certificate of Merger has been executed on this 23rd day of August 2001.

AGERE SYSTEMS GUARDIAN CORP.

By Gerard A. deStasi
Gerard A. deStasi
Vice President

Sep-20-2001 04:35am From-AGERE SYSTEMS INC,

8085826766

T-642 P.003/006 F-985

PTO/SB/96 (08-00)

Approved for use through 10/31/2002. OMB 0651-0031

U. S. Patent and Trademark Office; U. S. DEPARTMENT OF COMMERCE

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STATEMENT UNDER 37 CFR 3.73(b)Applicant/Patent Owner: Agere Systems Guardian Corp.

Application No./Patent No.: _____ Filed/Issued Date: _____

Entitled: _____

Agere Systems Guardian Corp corporation

(Name of Assignee)

(Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

States that it is:

1. ☒ the assignee of the entire right, title, and interest; or
2. ☐ an assignee of less than the entire right, title and interest.
The extent (by, percentage) of its ownership interest is _____ %

In the patent application/patent identified above by virtue of either:

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OR

B. ☒ A Chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as shown below:

1. From Inventor(s) To: Lucent Technologies Inc.
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.
2. From Lucent Technologies Inc. To: Agere Systems Optoelectronics Guardian Corp.
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.
3. From Agere Systems Optoelectronics Guardian Corp. To: Agere Systems Guardian Corp.
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.

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[Note: A separate copy (i.e., the original assignment document or a true copy of the original document) must be submitted to Assignment Division in accordance with 37 CFR Part 3, if the assignment is to be recorded in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Date

Typed or printed name

Signature

Corporate Counsel

Title

EXECUTION COPY

PATENT ASSIGNMENT

by and between

LUCENT TECHNOLOGIES INC.

and

AGERE SYSTEMS OPTOELECTRONICS GUARDIAN CORP.

Dated as of January 30, 2001

PATENT ASSIGNMENT

THIS PATENT ASSIGNMENT (this "Assignment"), effective as of January 30, 2001 (the "Effective Date"), is by and between Lucent Technologies Inc., a Delaware corporation, with offices at 600 Mountain Avenue, Murray Hill, New Jersey 07974, United States of America, ("ASSIGNOR") and Agere Systems Optoelectronics Guardian Corp., a Delaware corporation, with offices at 555 Union Boulevard, Allentown, PA 18109, United States of America ("Agere Systems Optoelectronics Guardian").

RECITALS

A. WHEREAS, the Board of Directors of ASSIGNOR has determined that it is in the best interests of ASSIGNOR and its stockholders to separate ASSIGNOR's existing businesses into two independent businesses;

B. WHEREAS, ASSIGNOR presently owns or controls certain patents, patent applications, and invention submissions listed in the attached Appendices A and B (hereinafter "TRANSFERRED PATENTS") and;

C. WHEREAS, in furtherance of the foregoing separation, ASSIGNOR desires to transfer, assign, convey, deliver and vest all of its interests and rights in TRANSFERRED PATENTS for all countries, jurisdictions and political entities of the world, to and in Agere Systems Optoelectronics Guardian;

NOW, THEREFORE, in consideration of the premises and for other good and valid consideration, the receipt and sufficiency of which are hereby acknowledged, the parties, intending to be legally bound, agree as follows:

ASSIGNOR, subject to existing rights and licenses of third parties, does hereby assign, convey, transfer and deliver, and agrees to assign, convey, transfer and deliver to Agere Systems Optoelectronics Guardian, its successors, assigns and legal representatives or nominees, ASSIGNOR's entire right, title and interest, for all countries, jurisdictions and political entities of the world, along with the right to sue for past infringement, to all TRANSFERRED PATENTS listed on Appendices A and B, and corresponding counterpart foreign patents and patent applications, with respect to which, and to the extent to which, ASSIGNOR now has or hereafter acquires the right to so assign, convey, transfer and deliver. Agere Systems Optoelectronics Guardian recognizes that ASSIGNOR holds only bare legal title to the TRANSFERRED PATENTS listed in Appendix A (which lists the United States Patents and patent applications previously exclusively licensed to Lucent Technologies Optoelectronics Guardian Corp.).

ASSIGNOR and ASSIGNEE recognize that the patents listed in Appendices A and B may inadvertently include patents that are owned by various subsidiaries of ASSIGNOR, including Agere, Inc., Ortel Corporation, Optimay Corporation, Herrmann Technology, Inc., and

Enable Semiconductor, Inc. Ownership of such patents shall not be affected by this Patent Assignment, and ASSIGNEE agrees that any such patents shall be deemed deleted from Appendices A and B.

ASSIGNOR agrees that, upon request it will, at any time without charge to Agere Systems Optoelectronics Guardian, but at Agere Systems Optoelectronics Guardian's expense, furnish all necessary documentation relating to or supporting chain of title, sign all papers, take all rightful oaths, and do all acts which may be necessary, desirable or convenient for vesting title to TRANSFERRED PATENTS in Agere Systems Optoelectronics Guardian, its successors, assigns and legal representatives or nominees; including but not limited to any acts which may be necessary, desirable or convenient for claiming said rights and for securing and maintaining patents for said inventions in any and all countries and for vesting title thereto in Agere Systems Optoelectronics Guardian and its respective successors, assigns and legal representatives or nominees.

IN WITNESS WHEREOF, the parties have caused this PATENT ASSIGNMENT to be executed by their duly authorized representatives as of the Effective Date.

LUCENT TECHNOLOGIES INC.

By: 
Daniel P. McCurdy
President, Intellectual Property Business

**AGERE SYSTEMS OPTOELECTRONICS
GUARDIAN CORP.**

By: 
Fred M. Romano
President

Execution Copy

ACKNOWLEDGMENTS

STATE OF NEW JERSEY)

: ss:

COUNTY OF SOMERSET)

I CERTIFY that on January 30, 2001, Daniel P. McCurdy personally came before me and this person acknowledged under oath, to my satisfaction that:

a.) this person signed, sealed and delivered the attached Patent Assignment as President - Intellectual Property Business of Lucent Technologies Inc.; and

b.) this Patent Assignment was signed and made by Lucent Technologies Inc. as its voluntary act and deed by virtue of authority from its Board of Directors.



Name

Notary Public

My Commission Expires TAMORA ANNE HANNA

[Notarial Seal]

Notary Public of New Jersey

Registered in Hunterdon County

My Commission Expires March 25, 2002

STATE OF FLORIDA)

: ss:

COUNTY OF ORANGE)

I CERTIFY that on January 31, 2001, Fred M. Romano personally came before me and this person acknowledged under oath, to my satisfaction that:

a.) this person signed, sealed and delivered the attached Patent Assignment as Vice President of Agere Systems Optoelectronics Guardian Corp. ; and

b.) this Patent Assignment was signed and made by Agere Systems Optoelectronics Guardian Corp. as its voluntary act and deed by virtue of authority from its Board of Directors.

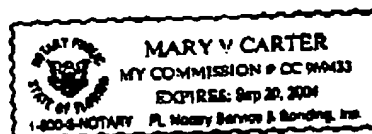


Name

Notary Public

My Commission Expires:

[Notarial Seal]



APPENDIX B (continued)

Transferred Patents

IDS No.	Inventors	Subject Matter
114125	Ernest Eisenhardt Bergmann	Walk-Off End Assembly For Mirror Switching
121529	Miri Park	Holographic Grating Fabrication Using A Corner Cube Mirror With A Surface Curvature
121543	Abdallah Ougazzaden; Michael Geva; Yuliya Anatolyevna Akulova	Application Of InAlAs Double-Layer To Block Dopant Out-Diffusion In III-V Device Fabrication
121912	Mary J Nadeau; Renyi Yang; Craig A Young; Paul Nicholas Pappas; Steven L Moyer; Hong-Tai Man; Rao V Yelamarty	Laser Packaging Arrangement
122060	Christopher Richard Doerr; Robert M Pafchek	Reduced Power Consumption Thermo-Optic Devices
122064	Ernest Eisenhardt Bergmann; Harvey Lawrence Wagner; Neal Henry Thorsten	Polarization Independent Wavelength Combiner Distributor
122325	Shachar Richter; Michael Geva; Rafael Nathan Kleiman	Dual Polarity Current Amplifier With 14 Decades Of Amplification And Large Bandwidth
122508	Leonard Jan-Peter Ketelsen; Richard Bendicks Bylsma	Integrated Capacitor For Crosstalk Reduction In Tunable Lasers
122510	Curtis Anthony Jack; John William Osenbach	Fiber Assembly That Eliminates Optical Instabilities Due To Improperly Cured Epoxy
122512	G Jacob Fox; Kevin J Sullivan; Robert Anthony Baron; Mark Bernard Cholewa	Novel Method For Preventing Gold Or Solder Adhesion During Facet Coating
122607	Lin Huang; Justin Boyd Judkins	Dispersion Compensation Device
122690	Dennis Tak Tong	160 Gbit/s Clock Recovery Using Electroabsorption Modulator-Based Phase-Locked Loop
122702	Jane D LeGrange; Susanne Arney; Katherine H Bogart; Avinoam Kornblit; Linda M Braun; Alexandru Paunescu	An Optical Device With Power Monitoring Component And Process For Making Same
122842	Kishore K Kamath	Active Phase Tuning Of DBR Lasers
122845	Abdallah Ougazzaden; Yuliya Anatolyevna Akulova; Kenneth Gerard Glogovsky; Mark S Hybertsen; Charles William Lentz	Technique For Thermal Stability Of Hydrogenation In The Passive Devices
122846	Robert W Smith	Silica Waveguide Switchback For Integrated Optical Devices
122847	Jin Hong Lim	Passively Output-Flattened Optical Amplifier
122848	Yongqiang Shi	New Two-Step Ti:LiNbO ₃ Waveguide Fabrication Method For Low Coupling Loss And Low Driving Voltage
122849	Yongqiang Shi	Grating Coupler For Surface-Mount Photodetector On Lithium Niobate Waveguide and PLCs
122852	William E Derbyshire; Dharendra S Bora	Fiber Amplifier Package
122857	Albert Michael Benzoni	A High Speed Lensless Fiber-to-Photodetector Die O/E Interface Up to 40Gbps

FEB 28 2002



UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO.	DRAWINGS	TOT CLAIMS	IND CLAIMS
10/015,477	12/13/2001	2859	812	TONG 2	7	24	3

CONFIRMATION NO. 6646

8933
DUANE MORRIS, LLP
ATTN: WILLIAM H. MURRAY
ONE LIBERTY PLACE
1650 MARKET STREET
PHILADELPHIA, PA 19103-7396

FILING RECEIPT



OC000000007516854

Date Mailed: 02/22/2002

Receipt is acknowledged of this nonprovisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Customer Service Center. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).

Applicant(s)

Dennis Tong, Middletown, NJ;

Domestic Priority data as claimed by applicant

THIS APPLN CLAIMS BENEFIT OF 60/294,693 05/31/2001

Foreign Applications

If Required, Foreign Filing License Granted 02/21/2002

Projected Publication Date: To Be Determined - pending completion of Corrected Papers

Non-Publication Request: No

Early Publication Request: No

Title

Opto-electronic phase-locked loop with microwave mixing for clock recovery

Preliminary Class

368

**LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15**

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Office of Export Administration, Department of Commerce (15 CFR 370.10 (j)); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

Lucent Technologies
Bell Labs Innovations



Lisa M. Connolly

Jeffery Brosemer
HO 3K-223
FAX: 949-7290

Jeffrey:

We are seeking publication release of the attached paper
"160 Gbit/s Clock Recovery using Electroabsorption Modulator-Based
Phase-locked Loop" for publication in *Electronic Letters*.
I would appreciate it if you could contact me within a week, letting me
know whether or not the Intellectual Property-Law has any objection to
the release of this material. Your approval (verbal or written) at this
stage is required before we can proceed to request Mr. Glass' approval
of the release.

This paper DOES contain patentable information.

Lisa Connolly/for Dennis Tong

Lucent Technologies
Bell Laboratories Innovations
101 Crawfords Corner Road
Room 4B-405
Holmdel, NJ 07733-0400
Phone: (732) 949-9185
Fax: (732) 949-2473

JEFFERY BROSEMER

APPROVAL DATE

160 Gbit/s Clock Recovery using Electroabsorption Modulator-Based Phase-locked Loop

Dennis T. K. Tong, Kung-Li Deng, Benny Mikkelsen, Greg Raybon, Kevin F. Dreyer, and John
E. Johnson¹

Lucent Technologies Bell Laboratories, Holmdel, NJ 07733, USA

¹Lucent Technologies Bell Laboratories, Murray Hill, NJ 07974, USA

ABSTRACT

Clock Recovery from 160 Gbit/s optical time-division-multiplexed data stream is experimentally demonstrated using an electroabsorption modulator-based phase-locked loop. The recovered clock signal exhibits excellent stability, with a rms timing jitter of < 230 fs, a dynamic range of 25 dB, and a hold range of ± 8 MHz.

160 Gbit/s Clock Recovery using Electroabsorption Modulator-Based Phase-locked Loop

Dennis T. K. Tong, Kung-Li Deng, Benny Mikkelsen, Greg Raybon, Kevin F. Dreyer, and John
E. Johnson¹

Lucent Technologies Bell Laboratories, Holmdel, NJ 07733, USA

¹Lucent Technologies Bell Laboratories, Murray Hill, NJ 07974, USA

Introduction: In future high-speed optical time-division-multiplexed (OTDM) networks, clock recovery at tributary rate from the multiplexed data stream [1-6] is an essential process as it synchronizes operations such as demultiplexing and 3R data regeneration at each network node. Among various clock recovery schemes, phase-locked loop (PLL) is the most established technique and recovered clocks with sub-picosecond timing jitters from high-speed data stream have been reported [3-5]. For example, an electrical PLL has been employed to extract a 10 GHz clock from 100 Gbit/s data stream [4]. Recently, single channel transmissions at 160 Gbit/s and beyond have been reported [7, 8]. At data rate beyond 100 Gbit/s, PLL with optical/optoelectronic phase detector provides a viable alternative to its all-electrical counterpart. We have previously reported an electroabsorption modulator-based PLL (EA-PLL) for clock recovery up to 80 Gbit/s [5]. EA modulators have advantages in stability, compactness and excellent extinction ratio. When driven under large sinusoidal signal, EA modulators typically produce switching windows of 10 ps or less. The switching windows can further be reduced by concatenating more than one modulator, allowing simple upgrade as the data rate increases. In

the Letter, we experimentally demonstrate an EA-PLL for 10 GHz clock extraction from 160 Gbit/s OTDM signal. Two EA modulators are concatenated in the PLL to reduce the switching window sufficiently for resolving the 160 Gbit/s data stream. The EA-PLL offers a simple and scalable solution for clock recovery in future high-speed OTDM systems.

Principle: Figure 1(a) shows the experimental setup EA-PLL. The incoming OTDM data stream is sampled by a voltage controlled oscillator's (VCO's) output through a pair of concatenated EA modulators. Before locking, the VCO runs at the intended clock frequency (i.e. 10 ± 0.001 GHz) with its phase to be locked onto the input data. Details of the concatenated modulators are shown in Fig. 1(b). The first EA modulator, which is connected to the output of a microwave frequency doubler, is driven at 20 GHz whereas the second EA modulator is driven at 10 GHz and is monolithically integrated with a semiconductor optical amplifier (SOA). The sampled data is directly detected by a 12 GHz photodetector. In RF spectrum, the mixing product between the VCO's output and the input data consists of phase error sidebands centered at dc and various clock frequency harmonics, i.e. 10, 20, 30 GHz...etc. In this scheme, those phase error sidebands centered at 10 GHz is extracted and down-converted to baseband through a microwave mixer. Due to the bandwidth of the microwave mixer's RF port (8 – 12 GHz), dc offset arises from the average optical power of the sampled data is filtered out and therefore polarity of the down-converted error signal is well-defined. The down-converted error signal is then processed by a second-order low-pass filter and fed back to the VCO for phase tracking.

Experiment and results: To generate an OTDM data stream for the clock recovery experiment, a 40 Gbit/s data with a word length of $2^{31} - 1$ is encoded onto CW optical signal at 1553 nm using

a Mach Zehnder LiNbO_3 modulator. The 40 Gbit/s non-return-to-zero (NRZ) data is then converted to return-to-zero (RZ) format with a pulsewidth of 2.0 ps. The transform-limited 2.0 ps pulses are generated by a sinusoidally driven EA modulator at 40 GHz, followed by an optical 2R regenerator [9] which performs reshaping and nonlinear optical pulse compression. The 40 Gbit/s RZ data is then time-multiplexed to 160 Gbit/s by bit-interleaving through two stages of optical fiber delay lines. To assure data decorrelation between adjacent channels, the delaying branches in both stages of the multiplexer consist of more than 20 meters of fiber. Figure 2(a) shows the multiplexed 160 Gbit/s data stream as measured on a streak camera with a resolution of 4 ps. Clock recovery is first performed with an input optical power of -2.0 dBm. When the phases of the driving signals to the concatenated EA modulators are appropriately adjusted, the optimized switching window is ~ 4 ps with a suppression ratio of better than 23 dB. Figures 2(b) and 2(c) show the oscilloscope trace and the RF spectrum of the corresponding recovered clock at 10 GHz, respectively. The carrier-to-noise ratio (CNR) at 10 kHz offset is measured to be -87 dBc/Hz. Integrating the noise pedestal results in a rms timing jitter of ~ 214 fs.

In Fig. 3(a), the timing jitter of the recovered clock is then measured as a function of input optical power to the EA-PLL. When the input optical power decreases from $+13.0$ to -12.0 dBm, the timing jitter increases monotonically but stays below 230 fs over the entire range. It should also be mentioned that the recovered clock exhibits excellent phase stability with no measurable drift over the entire 25 dB range. Such large dynamic range of the EA-PLL can be attributed to the use of erbium-doped fiber amplifiers (EDFAs) in the concatenated EA modulators (see Fig. 1(b)). The EDFAs operate in saturated regime for most of the tested range and therefore compensate for the variation in input power. Nevertheless, changing the input optical power affects in-band amplified stimulated emission (ASE) noise at the EDFA's output

and hence the timing jitter of the recovered clock. Figure 3(b) shows the measured timing jitter as the frequency of the VCO is detuned from the intended clock frequency. The input optical power to the EA-PLL for this measurement is -2.0 dBm. The timing jitter is at its minimum when the VCO frequency is set closest to the intended clock frequency, and increases when the VCO frequency is detuned in either direction. The hold range of the EA-PLL is ± 8 MHz.

Conclusion: In conclusion, a highly robust electroabsorption modulator-based phase locked loop is experimentally demonstrated for 160 Gbit/s clock recovery. The recovered clock signal maintains low rms time jitter (< 230 fs) over a 25 dB range of input optical power and a frequency detune of ± 8 MHz. The scheme presents a key enabling technologies for future ultra high-speed optical time-division-multiplexed networks.

References:

1. S. Kawanishi and M. Saruwatari, "Ultra-high-speed PLL-type clock recovery circuit based on all-optical modulation in travelling-wave laser diode amplifier," *J. Lightwave Technol.*, vol. 11, pp. 2123-2129, 1993.
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3. I. D. Philips, A. Gloag, D.G. Moodie, N.J. Doran, I. Bennion, and A.D. Ellis, "40 Gbit/s 'drop and insert' multiplexing with novel clock recovery using an electroabsorption modulator in a bi-directional configuration," *Proc. ECOC'97*, Postdeadline Paper, pp. 81-84, 1997.
4. I. D. Philips, A.D. Ellis, T. Widdowson, D. Nasset, A.E. Kelly, and D. Tommer, "100 Gbit/s optical clock recovery using electrical phase-locked loop consisting of commercially available components," *Electron. Lett.*, vol. 36, pp. 650-652, 2000.
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6. F. Cisternini, R. Girardi, S. Römisch, R. Calvani, E. Riccardi, and P. Garino, "A novel approach to pre-scaled clock recovery in OTDM systems," *Proc. ECOC'98*, vol. 1, pp. 477-479, 1998.
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9. P. V. Mamyshev, "All-optical data regeneration based on self-phase modulation effect," *Proc. ECOC'98*, pp. 475-476, 1998.

Figure Captions:

- Fig. 1 (a) Experimental setup of the EA-PLL and (b) details of the concatenated EA modulators. OF: Optical filter.
- Fig. 2 (a) 160 Gbit/s data measured on streak camera trace with 4 ps resolution. (b) Oscilloscope trace and (c) RF spectrum of the corresponding recovered clock at 10 GHz.
- Fig. 3 Measured timing jitter of the recovered clock versus (a) input optical power to the EA-PLL, and (b) detune frequency of the VCO relative to the intended clock frequency. Input optical power in (b) is -2.0 dBm.

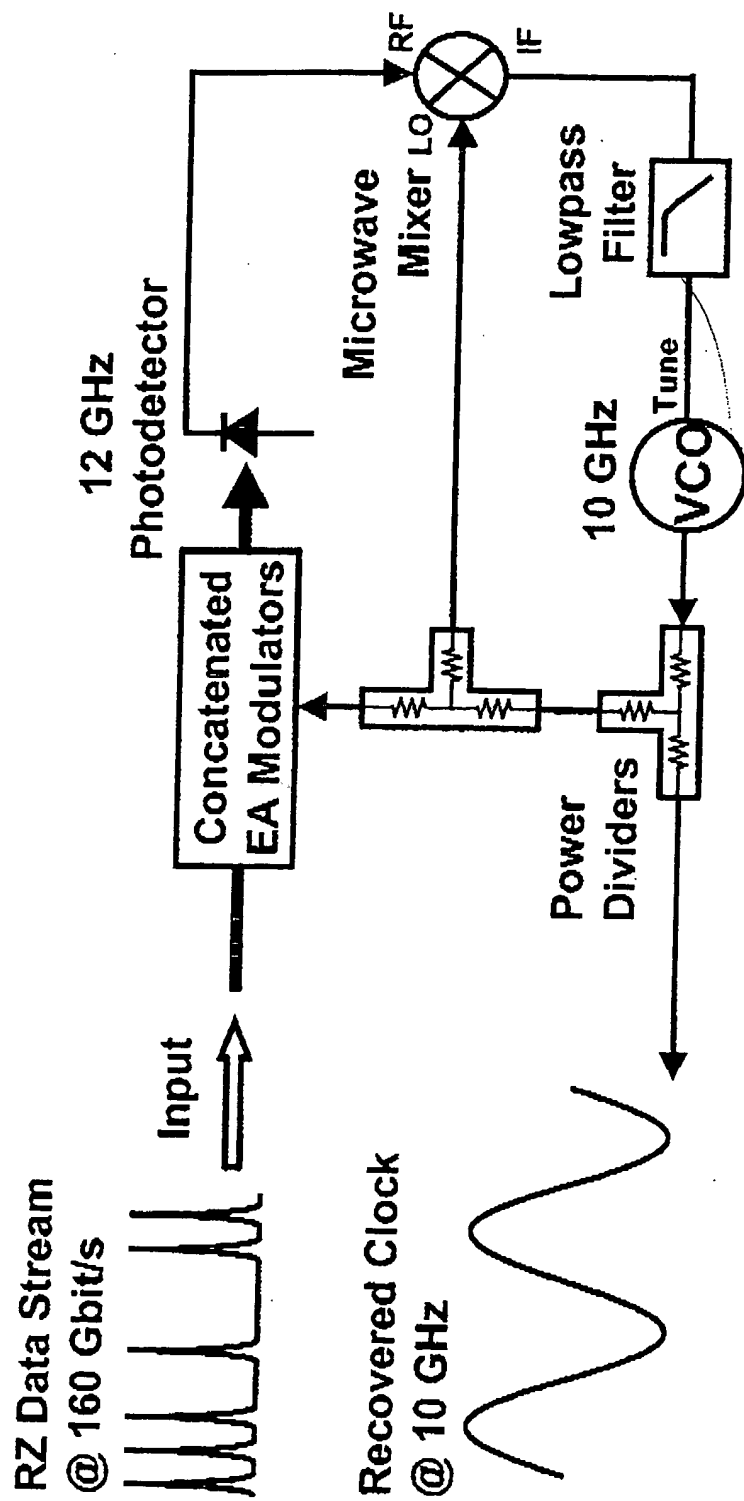


Fig. 1(a)

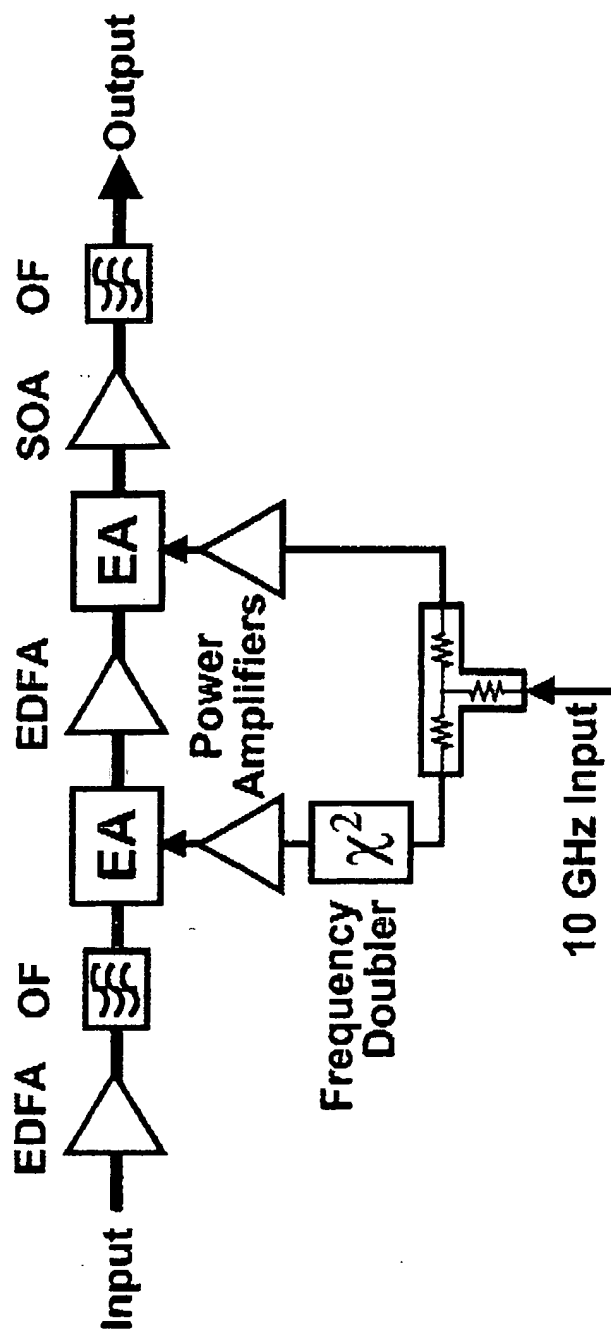


Fig. 1(b)

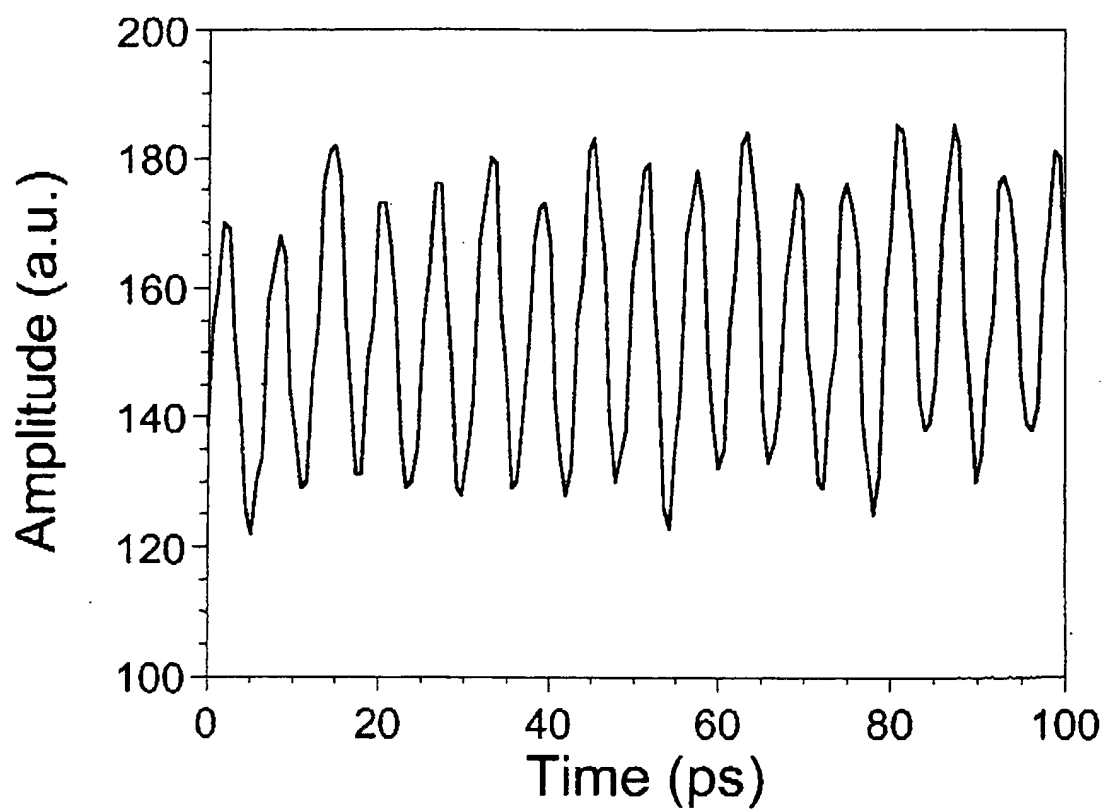
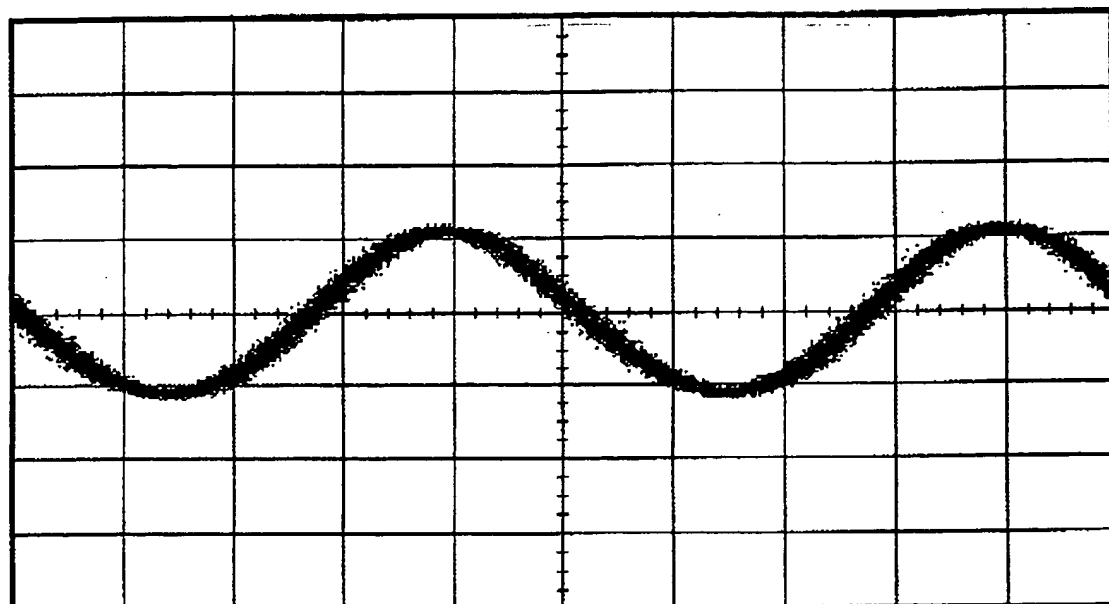


Fig. 2(a)

Relative Amplitude (a.u.)



20 ps/div

Time (ps)

Fig. 2(b)

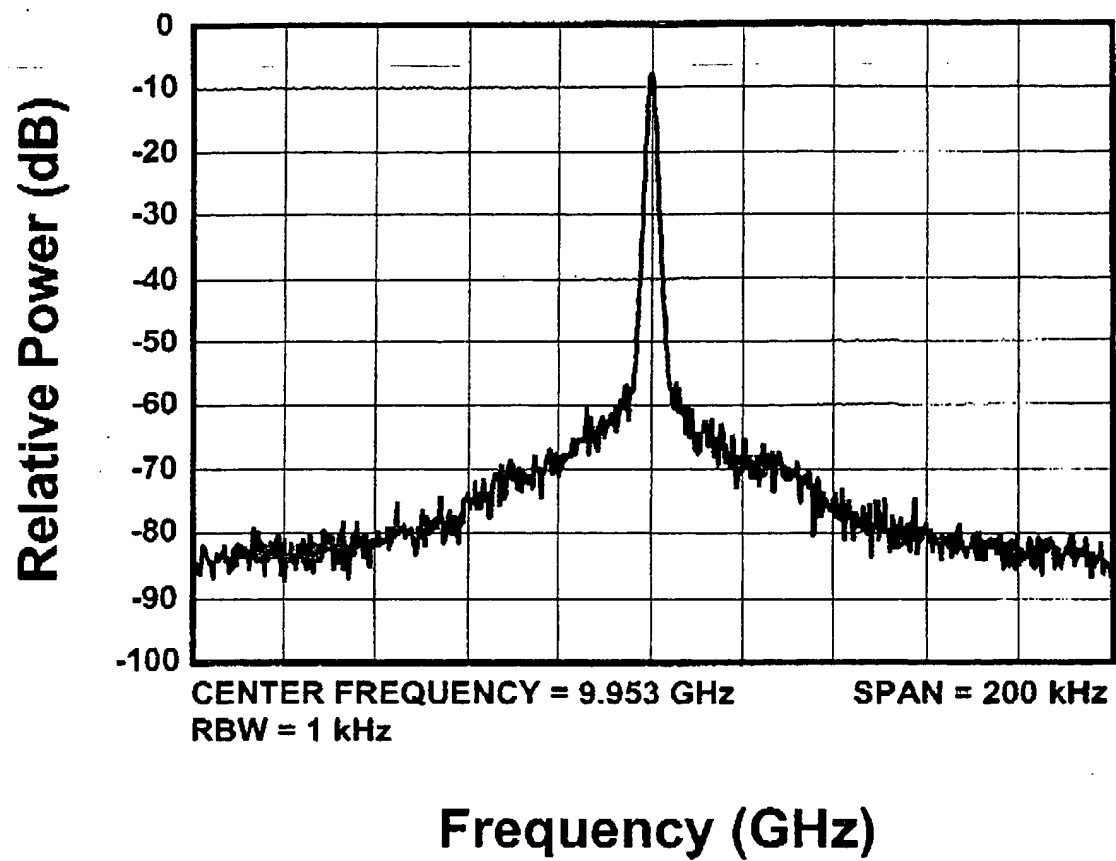


Fig. 2(c)

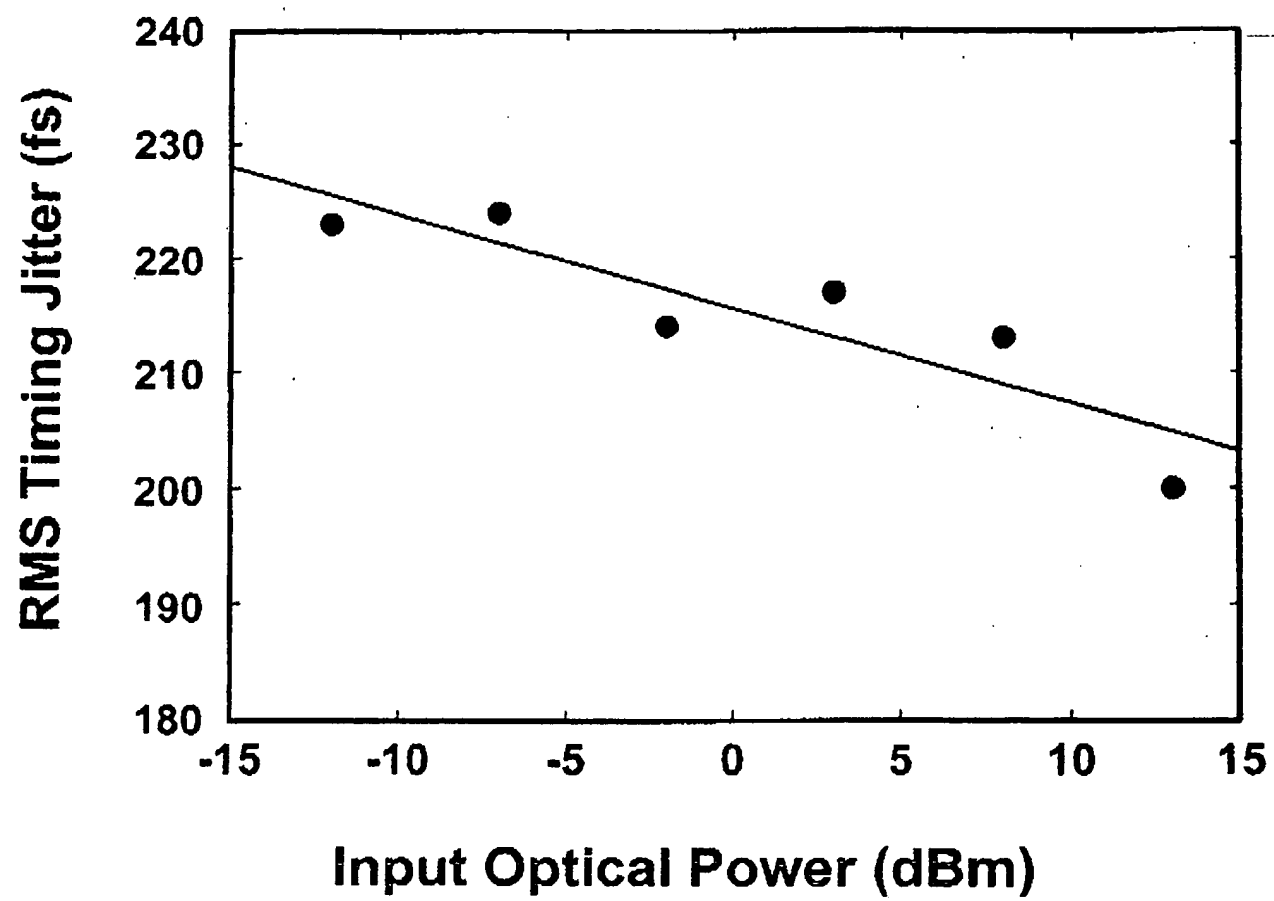


Fig. 3(a)

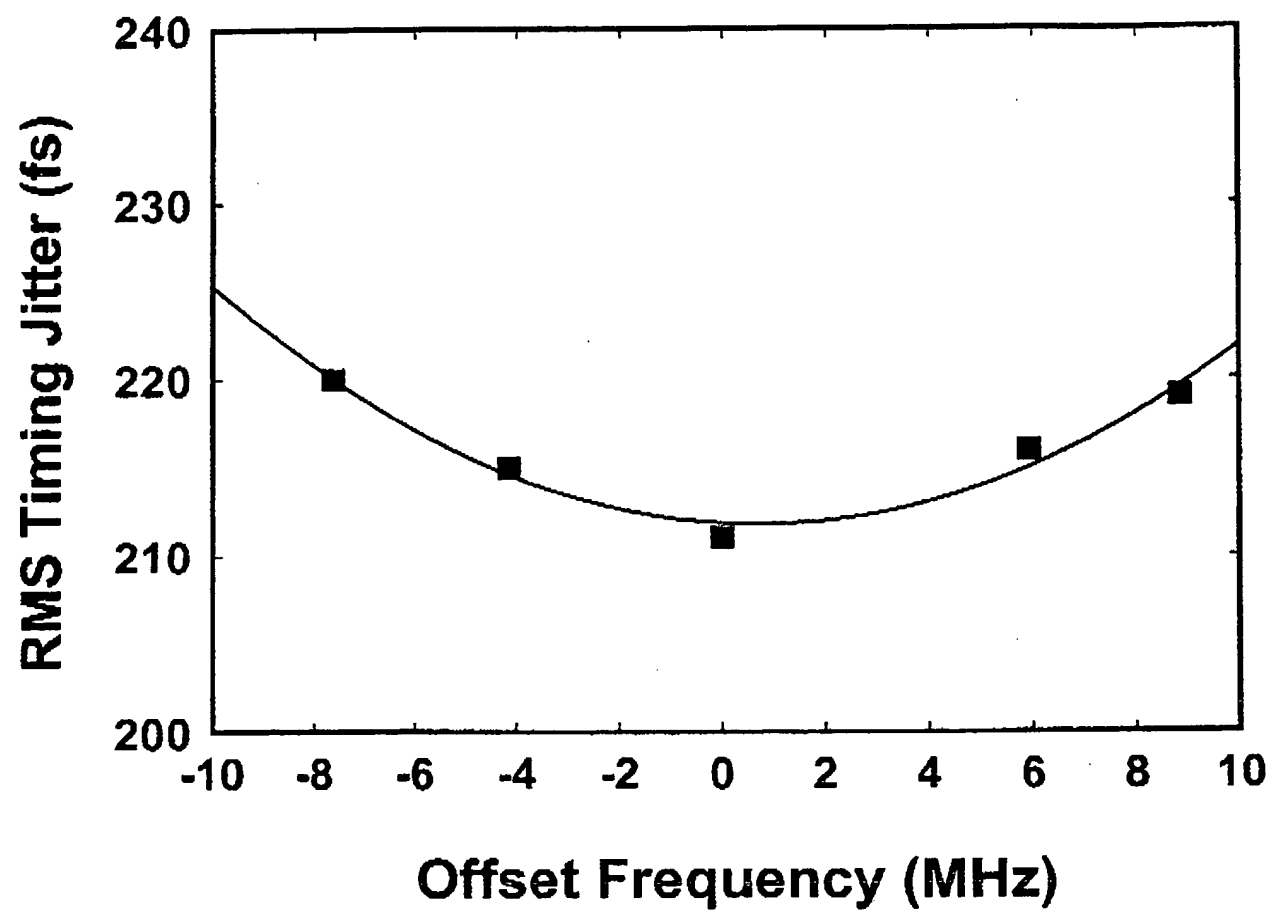


Fig. 3(b)



Subject: **Patent Submission IDS # 122690**
*"160 Gbits Clock Recovery Using
Electroabsorption Modulator-Based
Phase-Locked Loop"*

Date: **June 22, 2000**

From: **Jeffery J. Brosemer**
Intellectual Property-Law
HO 3K-234 (732) 949-6710

Ed Szurkowski:

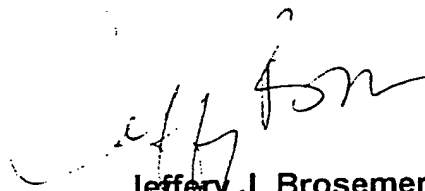
Patentability Item #122690 has been formally docketed to consider the patentability of the above-identified subject matter D. T. K. Tong appears to be the originator.

Should you have any questions regarding the subject matter, please feel free to contact me.

HO-P33A70000-JJB-bjm

Copy to:
D. T. K. Tong
M. C. Nuss

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Jeffery J. Brosemer
Corporate Counsel


Gerald Kito

MAR - 9 2005

Subject: Patent Submission IDS # 122690
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Copy to:
D. T. K. Tong
M. C. Nuss


Jeffery J. Brosemer
Corporate Counsel

SUBMISSION NO. : 122690
ATTORNEY : Brosemer, Jeffery J
Title :

160 Gbit/s Clock Recovery Using Electroabsorption Modulator-Based Phase-Locked Loop

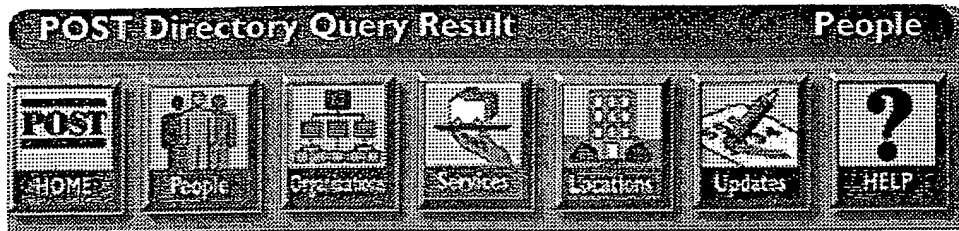
-----MAIN INFORMATION-----

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OPEN DATE	: 6/20/00	TYPE	: Patentability
CLOSE DATE	:	DEADLINE DATE	:
CLASS CODE	:	TECHNOLOGY	:
BU CODES(S)	: N/A		

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- 5 ZITELLI, M., MATERA, F., and SETTEMBRE, M.: 'Single-channel transmission in dispersion management links in conditions of very strong pulse broadening: application to 40Gb/s signals on step-index fibers', *J. Lightwave Technol.*, 1999, 17, (12), pp. 2498-2505

160Gbit/s clock recovery using electroabsorption modulator-based phase-locked loop

D.T.K. Tong, Kung-Li Deng, B. Mikkelsen, G. Raybon, K.F. Dreyer and J.E. Johnson

Clock recovery from a 160Gbit/s optical time-division-multiplexed data stream is experimentally demonstrated using an electroabsorption modulator-based phase-locked loop. The recovered clock signal exhibits excellent stability, with an RMS timing jitter of < 230fs, a dynamic range of 25dB, and a locking range of 16MHz.

Introduction: In future high-speed optical time-division-multiplexed (OTDM) networks, clock recovery at tributary rates from the multiplexed data stream [1-6] will be an essential process as it synchronises operations such as demultiplexing and 3R data regeneration at each network node. Among the various clock recovery schemes, use of the phase-locked loop (PLL) is the most established technique, and recovered clocks with sub-picosecond timing jitters from a high-speed data stream have been reported [3-5]. For example, an electrical PLL has been employed to extract a 10GHz clock from a 100Gbit/s data stream [4]. Recently, single channel transmissions at 160Gbit/s and beyond have been reported [7, 8]. At data rates beyond 100Gbit/s, a PLL with an optical/optoelectronic phase detector provides a viable alternative to its all-electrical counterpart. We have previously reported an electroabsorption modulator-based PLL (EA-PLL) for clock recovery up to 80Gbit/s [5]. EA modulators have advantages in terms of stability, compactness and excellent extinction ratio. When driven by a large sinusoidal signal, EA modulators typically produce switching windows of 10ps or less. The switching windows can be further reduced by concatenating more than one modulator, allowing simple upgrades as the data rate increases. In this Letter, we report on an EA-PLL for 10GHz clock extraction from a 160Gbit/s OTDM signal. Two EA modulators are concatenated in the PLL to reduce the switching window sufficiently to resolve the 160Gbit/s data stream. The EA-PLL offers a simple and scalable solution for clock recovery in future high-speed OTDM systems.

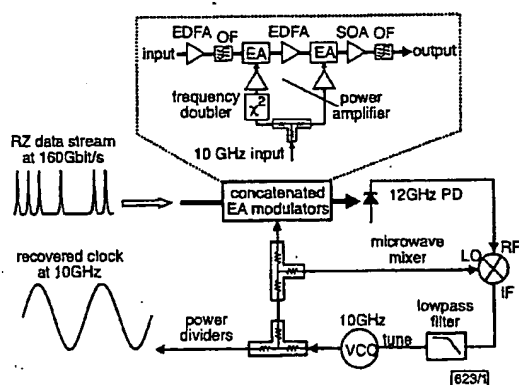


Fig. 1 Experimental setup of EA-PLL

Inset: Details of concatenated EA modulators
OF: optical filter

Principle: Fig. 1 shows the experimental setup of the EA-PLL. The incoming OTDM data stream is sampled by the output of a voltage controlled oscillator (VCO) through a pair of concatenated EA modulators. Before locking, the VCO runs at the

intended clock frequency (i.e. 10 ± 0.001 GHz) with its phase to be locked onto the input data. Details of the concatenated modulators are shown in the inset of Fig. 1. The first EA modulator, which is connected to the output of a microwave frequency doubler, is driven at 20GHz, whereas the second EA modulator is driven at 10GHz and is monolithically integrated with a semiconductor optical amplifier (SOA). The sampled data are directly detected by a 12GHz photodetector. In the RF spectrum, the mixing product between the output of the VCO and the input data consists of phase error sidebands centred at DC and various clock frequency harmonics, i.e. 10, 20, 30GHz, etc. In this scheme, those phase error sidebands centred at 10GHz are extracted and down-converted to baseband using a microwave mixer. Owing to the bandwidth of the RF port of the microwave mixer (8-12GHz), the DC offset arising from the average optical power of the sampled data is filtered out and therefore the polarity of the down-converted error signal is well-defined. The down-converted error signal is then processed by a lowpass filter and fed back to the VCO for phase tracking.

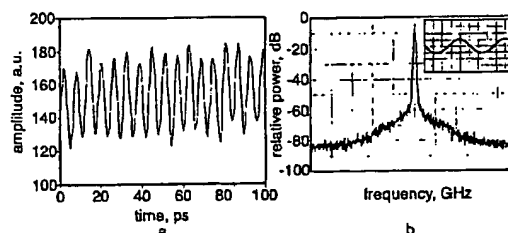


Fig. 2 Streak camera trace of 160Gbit/s data and RF spectrum of corresponding recovered clock

a 160Gbit/s data measured on streak camera trace with 4ps resolution
b RF spectrum of corresponding recovered clock at 10GHz
Centre frequency 9.953GHz, span 200kHz, RBW = 1kHz
Inset: Oscilloscope trace of recovered clock
20ps/div

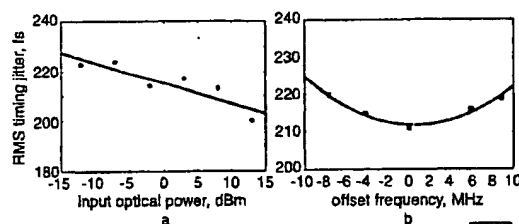


Fig. 3 Measured timing jitter of recovered clock against input optical power to EA-PLL and detuning frequency of VCO relative to intended clock frequency

a Timing jitter against input optical power
b Timing jitter against detuning frequency of VCO
Input optical power in b is -2.0dBm

Experiment and results: To generate an OTDM data stream for the clock recovery experiment, a 40Gbit/s data with a word length of $2^{31} - 1$ was encoded onto a CW optical signal at 1553nm using a Mach Zehnder LiNbO₃ modulator. The 40Gbit/s non-return-to-zero (NRZ) data were then converted to return-to-zero (RZ) format with a pulsewidth of 2.0ps. The transform-limited 2.0ps pulses were generated by a sinusoidally driven EA modulator at 40GHz, followed by an optical 2R regenerator [9], which performed reshaping and nonlinear optical pulse compression. The 40Gbit/s RZ data was then time-multiplexed to 160Gbit/s by bit-interleaving through two stages of optical fibre delay lines. To assure data decorrelation between the adjacent channels, the delaying branches in both stages of the multiplexer consisted of more than 20 metres of fibre. Fig. 2a shows the multiplexed 160Gbit/s data stream as measured on a streak camera with a resolution of 4ps. Clock recovery is first performed with an input optical power of -2.0dBm. When the phases of the driving signals to the concatenated EA modulators are appropriately adjusted, the optimised switching window is ~4ps with a suppression ratio of better than 23dB. Fig. 2b displays the RF spectrum of the cor-

responding recovered clock at 10GHz with the oscilloscope trace shown in the inset. The carrier-to-noise ratio (CNR) at 10kHz offset is measured to be -87dBc/Hz . Integrating the noise pedestal results in an RMS timing jitter of $\sim 214\text{fs}$.

The timing jitter of the recovered clock is then measured as a function of the input optical power to the EA-PLL in Fig. 3a. When the input optical power decreases from $+13.0$ to -12.0dBm , the timing jitter increases monotonically but stays below 230fs over the entire range. It should also be mentioned that the recovered clock exhibits excellent phase stability with no measurable drift over the entire 25dB range. Such a large dynamic range of the EA-PLL can be attributed to the use of erbium-doped fibre amplifiers (EDFAs) in the concatenated EA modulators (see inset of Fig. 1). The EDFAs operated in the saturated regime for most of the tested range and therefore compensated for the variation in the input power. Nevertheless, changing the input optical power affected the in-band amplified stimulated emission (ASE) noise at the output of the EDFA and hence the timing jitter of the recovered clock. Fig. 3b shows the measured timing jitter as the frequency of the VCO is detuned from the intended clock frequency. The input optical power to the EA-PLL for this measurement was -2.0dBm . The timing jitter was at its minimum when the VCO frequency was set closest to the intended clock frequency, and increased when the VCO frequency was detuned in either direction. The hold range of the EA-PLL was $\pm 18\text{MHz}$.

Conclusion: In conclusion, a highly robust electroabsorption modulator-based phase locked loop has been experimentally demonstrated for 160Gbit/s clock recovery. The recovered clock signal maintains low RMS time jitter ($< 230\text{fs}$) over an input optical power range of 25dB and frequency detuning of $\pm 8\text{MHz}$. The scheme should enable the realisation of technologies for future ultra high-speed optical time-division-multiplexed networks.

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Temperature dependency of x-cut LiNbO₃ modulator DC drift

H. Nagata, Y. Ishizuka and K. Akizuki

The activation energy (E_a) for DC drifts of x-cut LiNbO₃ (LN) modulators was obtained to be $1.4 \pm 0.2\text{eV}$ based on statistical consideration of long-term biased aging test data at 100 and 120°C . $E_a = 1.4\text{eV}$ means that 20 years of device life at 65°C - common system requirements - can be promptly tested by 9 days' aging at 120°C .

Introduction: In our previous investigation on DC drift of x-cut LN optical intensity modulators, we found that the drift curve was successfully expressed by the equation $A(t) = V(t)/V(0) = a \times t^n$, in which $V(t)$ is a bias voltage applied to the modulator at time t and $V(0)$ is the initially applied bias voltage [1]. The coefficient a was shown to depend on an operation temperature, while the index n was almost independent of the temperature [1]. From the temperature dependency of the linear rate coefficient $b = a^{1/n}$ observed in drift curves measured for 170h at 50 to 140°C , $E_a = 1.4\text{eV}$ was obtained for the DC drift of both 10Gbit/s x-cut LN modulators and x-cut LN attenuators. However, our previous experiments focused on the drift occurring within a very short period (the coefficient a was determined by $t = 1\text{h}$), and the effectiveness of $E_a = 1.4\text{eV}$ to long-term drifts was not shown. The purpose of this Letter is to review our previous results from a statistical viewpoint for long-term reliability data analyses. In this regard, a lognormal distribution function was applied to drift data measured for 200 to 2000h at 100 and 120°C , and the obtained median-life parameters on DC drift failures revealed E_a ranging from 1.28 to 1.60eV ; $E_a \approx 1.4 \pm 0.2\text{eV}$.

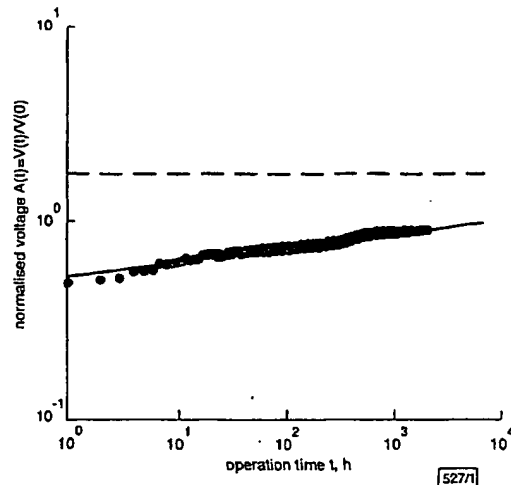


Fig. 1 Example of DC drift data measured at 100°C

Initial bias $V(0) = 15.5\text{V}$

--- $A(t)_{EOL} = 1.75$

— $A(t) = 0.5276 \times t^{0.0686}$, $R^2 = 0.9528$

Experiments and results: Fig. 1 gives an example of a DC drift curve measured on a 10Gbit/s x-cut LN modulator at 100°C using an auto bias control method. The initial bias voltage $V(0) = 15.5\text{V}$, in this case, was applied at 100°C and then the bias voltage $V(t)$ was adjusted each time by a control frequency of 1kHz to



subject: Transfer of IDS 122690 to Agere

date: January 26, 2001

from: Gregory C. Ranieri
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